REMARKS

Applicants thank the Examiner for the courtesy extended to Applicants' attorney during the interview held August 19, 2004, in the above-identified application. During the interview, Applicants' attorney explained the presently-claimed invention and why it is patentable over the applied prior art, and in particular, that thickness dispersion is not related to thickness *per se*, and noted the definition of thickness dispersion in the specification at page 3, lines 10-23 (now incorporated into the claims), and the description of Figures 4 and 5. The discussion is summarized and expanded upon below.

As recited in above-amended Claim 1, an aspect of the present invention is a hot plate for heating a wafer comprising a ceramic substrate in disc form, said ceramic substrate having a lower face and an upper face, wherein a resistance element pattern having a thickness dispersion of ±3 μm or less is formed on the lower face of the ceramic substrate, and said resistance element pattern is formed by a dry process, the thickness dispersion being the larger of the absolute value of Tmax – Tav and the absolute value of Tmin – Tav, Tav being an average thickness obtained by averaging thicknesses of arbitrarily selected 10 points of the resistance element, Tav being within a range of 3 to 500 μm, Tmax being the maximum thickness of said 10 points, and Tmin being the minimum thickness of said 10 points.

As recited in Claim 23, a second aspect of the present invention is a hot plate for heating a wafer comprising a ceramic substrate in disc form, said ceramic substrate having a lower face and an upper face, wherein a resistance element pattern having a thickness dispersion of ±3 μm or less is formed on the lower face of the ceramic substrate, and wherein said resistance element pattern is made of scaly noble metal powder, the thickness dispersion being the larger of the absolute value of Tmax – Tav and the absolute value of Tmin – Tav, Tav being an average thickness obtained by averaging thicknesses of arbitrarily selected 10

points of the resistance element, Tav being within a range of 3 to 500 μm, Tmax being the maximum thickness of said 10 points, and Tmin being the minimum thickness of said 10 points.

In order to improve temperature uniformity of a heating surface of a hot plate, it is more preferable to form a resistance element on the lower face of a ceramic substrate than to bury the resistance element inside the ceramic substrate. As illustrated by the **attached** Figs. A and B (similar in substance to Figs. A and B attached to the previous amendment), thermal diffusion is more effectively realized when the resistance element is formed on the lower face of the ceramic substrate since the distance between the resistance element and the heating surface is longer.

However, when the resistance element is formed on the surface of the ceramic substrate, the surface of the resistance element, the side which does not contact with the ceramic substrate, becomes rough so that dispersion in the thickness of the resistance element gets large. As a result, variation in the value of resistivity of the resistance element is generated and deteriorates the temperature uniformity of the heating surface.

Further, since the resistance element is formed on the lower face of the ceramic substrate, there is a problem that the resistance element may fall off the ceramic substrate because of gravity.

According to the present invention, uniform thickness of the resistance element without a problem of it falling off from the substrate is ensured by, for example, employing a dry process (Claim 1) or scaly noble metal powders (Claim 23).

A dry process is a method which enables depositing atoms directly on the surface. The resultant film formed on the surface has a high flatness. Scaly noble metal powders are used to prepare a resistance element paste which is printed on the surface and forms a layer

with a high flatness. Either of the above methods produces a resistance element pattern having a thickness dispersion of ±3 μm or less.

By decreasing the thickness dispersion, the temperature uniformity of the heating surface is realized. Such a small thickness dispersion has never been realized in the prior art.

As explained in the specification, at page 3, lines 10-23, and illustrated by **attached** Fig. C, the thickness dispersion is the larger of the absolute value of Tmax – Tav and the absolute value of Tmin – Tav.

The effect of the present invention is clearly shown from the comparison in the specification at page 13, line 7ff, of Samples 1-4, which are according to the present invention, and Sample 5, which is for purposes of comparison. The resistance elements of Samples 1-3 were formed by a dry process. The resistance element of Sample 4 was made of scaly noble metal powders. The thickness dispersions of the resistance elements of Samples 1-3 were ±1 μm or less, and were +0.7 μm, +0.5 μm and -0.3 μm, respectively. The thickness dispersion of the resistance element of Sample 4 was +2.0 μm. On the other hand, the resistance element of (comparative) Sample 5 was made of a commonly used silver paste. The thickness dispersion of the resistance element of Sample 5 was +3.1 μm.

Regarding the uniform heating of a wafer, and as described in the specification at page 15, line 7ff, the value of the dispersion in the temperature were within 0.2°C, 0.15°C, 0.1°C and 0.25°C in the tests of Samples 1, 2, 3 and 4, respectively. On the other hand, in the test of Sample 5, the value of the dispersion in the temperature was 0.4°C or less, clearly larger than the results of other Samples.

The above-discussed comparative results could not have been predicted by the applied prior art.

The rejections under 35 U.S.C. § 103(a) of:

Claims 1-5, 17-22 and 28 over U.S. 5,151,871 (Matsumura et al) in view of U.S. 6,133,557 (Kawanabe et al) or U.S. 6,080,970 (Yoshida et al);

Claims 23-27 over Matsumura et al in view of Kawanabe et al or Yoshida et al, and further in view of U.S. 5,118,983 (Morita et al) or U.S. 5,554,839 (Tsuruta et al); and

Claim 7 over Matsumura et al in view of Kawanabe et al or Yoshida et al, and further in view of U.S. 3,576,722 (Fennimore et al) or U.S. 5,442,239 (DiGiacomo et al),

are all respectfully traversed.

Matsumura et al discloses a method of heat-processing semiconductor devices whereby temperatures of the semiconductor devices can be controlled at devices-heating and –cooling times so as to accurately control their thermal history curve, the method comprising the steps of: storing, as a predetermined recipe, information showing a time-temperature relationship and applicable for either heating the object to a predetermined temperature for a predetermined period of time or cooling the object from a predetermined temperature over a predetermined period of time, or for both; reading the information and applying the information; heating the object by means of a conductive thin film in accordance with the information; detecting the temperature of the object directly or indirectly; and controlling either the heating of the object or the cooling thereof, or both, in accordance with the detected temperature and the information (paragraph bridging columns 2 and 3). As shown in Fig. 5A therein and described at column 5, line 13ff, stage 12 of the apparatus comprises an upper plate 13 made of alumina, a conductive thin film 14 formed on the whole areas of the underside of the upper plate 13, electrodes 15 and 16, and a protection film 21 made of tetrafluoroethylene. The conductive thin film 14 is coated together with the electrodes 15 and 16 by the protection film 21.

However, Matsumura et al neither discloses nor suggests a dry process nor a thickness dispersion of the resistance element. Therefore, it cannot be gleaned from Matsumura et al

that the conductive thin film 14 with a relatively small thickness dispersion can be formed by a dry process and that the temperature uniformity of the heating surface can be realized.

Further, the protection film 21 is made of a resin. It melts at a high temperature and causes a separation of the conductive thin film 14 and the electrodes 15 and 16.

According to the present invention (claim 1), on the other hand, the resistance element pattern is formed by a dry process and attached to the ceramic substrate. The resistance element pattern has a small thickness dispersion and the temperature uniformity of the heating surface is realized. Further, the hot plate has a high endurance at a high temperature.

Kawanabe et al relates to improvements in a wafer holding member generally made of an aluminum nitride-based sintered body in which electrodes and heating resistors are embedded (column 1, lines 5-15). The heating resistor has a thickness of 12 to 24 μm (Table 1).

The heating resistor of Kawanabe et al is not formed on the lower face of the base body, but is embedded in the base body. Further, Kawanabe et al discloses and suggests nothing about a thickness dispersion of their heating resistor. Nor does Kawanabe et al disclose or suggest a dry process. In Kawanabe et al, the heating resistor is formed by screen-printing a resistor paste on a green sheet, laminating a plurality of green sheets, and firing the lamination (column. 7, lines 30-39). Such a production method is not a dry process, but corresponds to the process used in the Comparative Example 1 of the specification herein. The heating resistor formed by such a method has a relatively large thickness dispersion. It is not possible to ensure the temperature uniformity of the heating surface.

Accordingly, it cannot be gleaned from Kawanabe et al that a heating resistor with a small thickness dispersion can be formed by a dry process, and that the temperature uniformity of the heating surface can be realized.

Yoshida et al discloses a wafer heating apparatus described as capable of producing uniform distribution of temperatures on all the area on the top surface to uniformly heat a wafer, wherein uniformity of heating the supporting surface of the wafer heating apparatus is improved by forming a strip heating resistor in concentric circles as the ideal heater pattern of the heating resistor (column 2, line 7ff). The wafer heating apparatus comprises a disk-shaped ceramic substrate and a strip heating resistor buried therein.

The heating resistor of Yoshida et al is not formed on the lower face of the ceramic substrate, but is buried in the ceramic substrate. Further, Yoshida et al discloses and suggests nothing about a thickness dispersion of the heating resistor.

Nor does Yoshida et al disclose or suggest a dry process. The heating resistor is formed by applying a conductive paste on a surface of a laminate sheet by screen printing, overlaying the remaining green sheets, and heating them (column 5, line 52 to column 6, line 2). Such a production method is not a dry process, but corresponds to the process used in the Comparative Example 1 of the specification herein. The heating resistor formed by such a method has a relatively large thickness dispersion. It is not possible to ensure the temperature uniformity of the heating surface.

Accordingly, it cannot be gleaned from Yoshida et al that a heating resistor with a small thickness dispersion can be formed by a dry process, and that the temperature uniformity of the heating surface can be realized.

As discussed above, neither Matsumura et al, Kawanabe et al, nor Yoshida et al disclose or suggest anything about a dry process. Therefore, the effect of the present invention cannot be foreseen from the cited references. Even if they were combined, the result would not be the presently-claimed invention.

Regarding Claim 23 and claims dependent thereon, the Examiner admits that neither Matsumura et al, Kawanabe et al, nor Yoshida et al disclose anything about scaly noble metal powder. The Examiner thus relies on Morita et al or Tsuruta et al.

Morita et al discloses a thermionic electron source used for an electron gun, a hot cathode X-ray tube or the like. As shown in Fig. 1, the high temperature operating element comprises a ceramic substrate 1, a resistive film 2 on the lower face of the ceramic substrate, and an element film 4 on the opposite face of the ceramic substrate. The element film 4 is heated from the rear and emits electrons if an electron emitting assistant is applied thereto (column 5, line 57 to column 6, line 3).

However, Morita et al discloses and suggests nothing about scaly noble metal **powder** nor about a thickness dispersion of their resistive film 2. Moreover, the thermionic electron source of Morita et al is completely different from the devices of Matsumura et al, Kawanabe et al, and Yoshida et al. Morita et al discloses and suggests nothing about temperature uniformity of a heating surface, or that such uniformity can be attained by adjusting the thickness dispersion of the resistance element within ±3 μm.

Tsuruta et al discloses a ceramic heater comprising a ceramic sintered body to which a flux for accelerating the sintering of the ceramic has been added and a metallic heating body, embedded in and contacting the ceramic sintered body for heating the ceramic sintered body when electric current is supplied thereto (column 2, lines 13-18). The heating body is obtained by screen-printing a Pt paste on an alumina green sheet and heating it (column 3, line 58 to column 4, line 31). Such a production method corresponds to the process used in Comparative Example 1 of the specification herein. The heating body formed by such a method has a relatively large thickness dispersion. It is not possible to ensure the temperature uniformity of the heating surface. Further, one cannot expect from Tsuruta et al that the temperature uniformity of the heating surface could be achieved by adjusting the thickness

dispersion of the resistance element within ±3 μm. Indeed, Tsuruta et al neither discloses nor suggests anything about scaly noble metal powder or thickness dispersion of the heating body.

Thus, as discussed above, neither Matsumura et al, Kawanabe et al, Yoshida et al, Morita et al, nor Tsuruta et al disclose or suggest anything about scaly noble metal powder or a thickness dispersion of the resistance element.

The Examiner admits that neither Matsumura et al, Kawanabe et al, nor Yoshida et al disclose or suggest a resistance element having a multilayer structure. The Examiner thus relies on Fennimore et al or DiGiacomo et al.

Fennimore et al discloses a method for metalizing ceramics which relates to production of microcircuitry (column 1, lines 31-33). The method according to Fennimore et al includes the step of applying a refractory metal (titanium) to a ceramic (aluminum oxide) substrate, and further includes the step of forming additional layers on the titanium layer (column 1, lines 43-51). The titanium film is applied by vacuum deposition accomplished through sputtering or by evaporation using an electron beam gun (column 2, lines 22-26).

However, Fennimore et al discloses and suggests nothing about a hot plate for heating a wafer. It is highly unlikely that the metal layers function as a resistance element. Nor does Fennimore et al disclose or suggest anything about a thickness dispersion of the metal layers. Therefore, one cannot learn from Fennimore et al the effect of the present invention, that is, the temperature uniformity of the heating surface achieved by adjusting the thickness dispersion of the resistance element within ±3 μm. Without the present disclosure as a guide, there would have been no motivation to combine Fennimore et al with Matsumura et al, and Kawanabe et al or Yoshida et al.

DiGiacomo et al is drawn to a semiconductor component, e.g., a chip (column 4, lines 32-35), not a hot plate, and neither discloses nor suggests that the metal film can be used as a

resistance element. DiGiacomo et al discloses that the metal layers can be formed by sputtering (column 4, lines 47-50), but is silent about the thickness dispersion of the metal layers. DiGiacomo et al relates to structure and method for corrosion- and stress-resistance interconnecting metallurgy. Fig. 1 shows a metal film structure deposited on a substrate. The film comprises a layer of chromium, a layer of nickel, and a layer of noble metal (column 4, lines 46-57).

However, DiGiacomo et al discloses and suggests nothing about a hot plate, or that their metal film can be used as a resistance element. Further, DiGiacomo et al is silent about the thickness dispersion of the metal layers. Therefore, one cannot glean from DiGiacomo et al the effect of the present invention, that is, the temperature uniformity of the heating surface achieved by adjusting the thickness dispersion of the resistance element within ±3 μm.

As discussed above, neither Matsumura et al, Kawanabe et al, nor Yoshida et al disclose or suggest anything about a thickness dispersion of the resistance element. Neither Fennimore et al nor DiGiacomo et al remedies the deficiency of these references. Indeed, neither Fennimore et al nor DiGiacomo et al disclose or suggest anything about a hot plate for heating a wafer, or the effect of the present invention, whereby temperature uniformity of the heating surface is achieved by adjusting the thickness dispersion of the resistance element within ±3 μm. Moreover, it is not clear why one skilled in the art would combine Matsumura et al, and Kawanabe et al or Yoshida et al, with Fennimore et al or DiGiacomo et al, but even if combined, the result would still not be the presently-claimed invention.

For all the above reasons, it is respectfully requested that these rejections be withdrawn.

Applicants gratefully acknowledge the Examiner's indication of allowability of the subject matter of Claims 8 and 9. Nevertheless, Applicants respectfully submit that all of the presently-pending and active claims in this application are now in immediate condition for

allowance. Accordingly, the Examiner is respectfully requested to pass this application to issue.

Respectfully submitted,

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